Expanded Monitoring Program

Near Deer Trail, Colorado

Quarterly Report
October–December 2000

Volume 2, no. 4

CONTENTS

USGS

The U.S. Geological Survey is a science organization that provides the Nation with reliable, impartial information to describe and understand the Earth. The national USGS home page: http://www.usgs.gov

This USGS program:

We have a new website for this program, which includes links for data and reports. The Internet address is: *http://webserver.cr.usgs.gov/projects/CO406/CO406.html*

The Internet address for just the data is: *http://nwis-colo.cr.usgs.gov/*

Program Overview

Metro Wastewater Reclamation District (Metro District) applies biosolids to their properties near Deer Trail, Colorado. These biosolids applications could affect the quality of water in alluvial and bedrock aquifers, streambed sediments, soils, and crops. Water quality can be directly affected through:

- Contaminated recharge water, or
- Infiltration of water through contaminated soils or sediments (remobilization).

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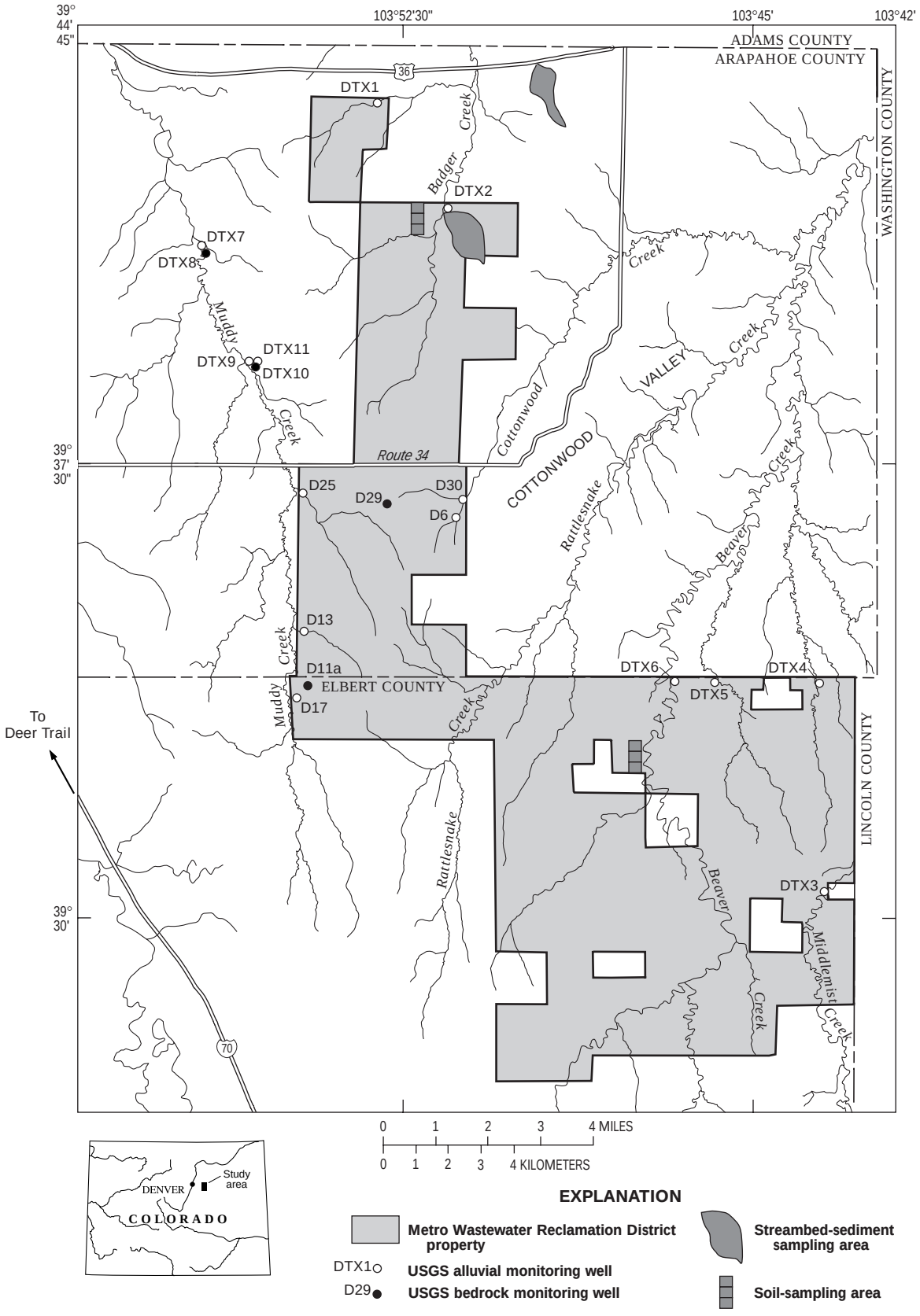
The USGS collects data for dissolved oxygen, pH, specific conductance, and water temperature for ground water in the field at each well using a single instrument. This instrument, a multiprobe, is calibrated each morning in the field before use at a well, and the calibration is checked at the end of each day of use.



USGS Expanded Monitoring Program sites and Metro District's biosolids-application properties near Deer Trail, Colorado

Program Overview

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Water quality can be indirectly affected through:

- Plowing that mobilizes or changes subsurface chemical constituents, or
- Contributions to natural processes such as nitrification.

Contaminated ground water or surface water could contaminate:

- Other aquifers, such as bedrock water-supply aquifers or alluvial aquifers,
- Other surface-water bodies (ponds or streams), or
- Streambed sediments.

Biosolids must meet metals and radioactivity regulations, or else agronomic loading rates will be incorrect and soils could be overloaded. Soil quality could either be improved by biosolids applications through increased nutrients and organic matter, or degraded through excessive nutrients or metals.

The U.S. Geological Survey (USGS) has designed and begun a new monitoring program to address concerns from a stakeholder group about the biosolids and the quality of the environment in the vicinity of the biosolids-application areas. The new USGS monitoring program near Deer Trail is referred to as the "USGS Expanded Monitoring Program" and began in January 1999.

This monitoring program is distinct from, but builds on, another USGS program that monitored shallow ground-water quality on the Metro District Central Farm from 1993-1998. The new program (1999-2005) considers environmental-quality issues for shallow and deep ground water, surface water (bed sediments), soils, crops, and the biosolids. The new expanded monitoring program includes all three Metro District properties (North, Central, and South Farms) and related private-property locations. Both programs, however, use USGS and Metro District funds. In addition, the new monitoring program also uses funds from the North Kiowa Bijou Ground Water Management District. Both programs are designed, carried out, and interpreted independently by USGS, and quality-assured USGS data and reports will be released to the public and the Metro District at the same time. By definition and design, all USGS monitoring programs are independent and unbiased.

The objectives of the new Expanded Monitoring Program are to: (1) Evaluate the combined effects of biosolids applications, land use, and natural processes on alluvial aquifers, the bedrock aquifer, streambed sediments, soils, and crops by comparing chemical data to

- State or Federal regulatory limits,
- Data from a site where biosolids are not applied (a control site), or
- Earlier data from the same site (trends).

(2) Monitor biosolids for metals and radioactivity, and compare the concentrations with regulatory limits. (3) Determine the aquifer hydrology in this area.

The approach is unique for each component of the Expanded Monitoring Program. However, appropriate USGS methods and technologies will be applied to each component.

Quarterly reports such as this one will be distributed to the stakeholders and other concerned people, as well as available to the general public on the Internet (http://co.water.usgs.gov). Each quarterly report will summarize progress from the previous quarter and plans for the current quarter; chemical data will be included every other quarter. A USGS report will be prepared annually and made available after each year of the monitoring program: the reports will include data for that year, any interpretations for that year, and statistical analysis for the data to date. A comprehensive USGS report will be prepared and available after five years of monitoring that includes complete statistical analyses and interpretations. In addition, the USGS will meet with the stakeholders once a year to discuss the Expanded Monitoring Program results and to consider possible changes to the Expanded Monitoring Program.

Questions & Answers

Q: Are the Metro District biosolids affected by the Lowry Landfill Superfund site?

A: The onsite water-treatment plant for the Lowry Landfill Superfund site began discharging treated ground water to the public sewer system in July 2000, but did not discharge from mid-October 2000 through mid-January 2001. Therefore, Metro District biosolids generated from about late October 2000 through mid-January 2001 likely were not affected by the Lowry Landfill Superfund site.

Q: Why are negative activity concentrations reported for the radionuclide data?

A: Radionuclide data are produced from instruments that detect radioactive decay (disintegrations) in a sample as counts per minute. Negative activity concentrations mean the sample counts were less than the laboratory background counts that day, so activity concentrations are negligible. Background counts are subtracted from the sample counts, then the resulting value is converted to activity-concentration units of picocuries per liter.

Alluvial Ground Water

Approach

Six monitoring wells were installed near the Metro District property boundaries in the major alluvial aquifers. These six wells plus five existing USGS monitoring wells will be sampled approximately quarterly for full inorganic chemistry and annually for radioactivity. Data will be reviewed and statistically tested for exceedance of regulations and for trends.

Progress Last Quarter (October-December 2000)

Ground-water levels were measured October 10-18, November 3, and December 2, 2000. Ground water was sampled for chemistry October 10-18, 2000. Ground-water data were compiled and reviewed. Another review of the annual report for 1999 was completed in mid-November. Review comments on this report were incorporated.

Plans for the Current Quarter (January-March 2001)

Ground-water levels will be measured the first week of each month. Ground water will be sampled in early January, weather permitting. All data obtained from the program to date will be compiled, reviewed, and evaluated. The second annual report (2000 data) will be started.

Bedrock Ground Water

Approach

A structure map of the base of the bedrock aquifer was compiled and used to determine locations for two sets of new, paired wells (one alluvial well and one nearby dual-completion bedrock well comprise each pair). The well pairs were installed where both the Muddy Creek alluvial aquifer and the Laramie-Fox Hills aquifer are present (along the margin of the bedrock aquifer) near the Metro District properties. Water-level data from each well pair will be used to determine aquifer hydrology and interaction at those two locations. The two new bedrock wells (DTX8, DTX10), along with an existing USGS bedrock well (D29), will be sampled approximately quarterly for full inorganic chemistry and annually for radioactivity. Data will be reviewed and statistically tested for exceedance of regulations and trends.

Progress Last Quarter (October-December 2000)

Ground-water levels were measured October 10-18, November 3, and December 2, 2000. Ground water was sampled for chemistry October 10-18, 2000. Ground-water data were compiled and reviewed. Another review of the annual report for 1999 was completed in mid-November. Review comments on this report were incorporated. The structure map and related interpretive work was completed and included in the draft report that was prepared for the original USGS monitoring program near Deer Trail (1993-1999).

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The recharge-evaluation site on the Weisensee Ranch consists of a continuous recorder, raingages, and pressure transducers in wells DTX9, DTX10, and DTX11. Data from this site are not transmitted by satellite (and therefore not available on the Internet), so the data must be downloaded manually onto a portable computer in the field.

Bedrock Ground Water

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Plans for the Current Quarter (January-March 2001)

Ground-water levels will be measured the first week of each month. Ground water will be sampled in early January, weather permitting. All data obtained from the program to date will be compiled, reviewed, and evaluated. The second annual report (2000 data) will be started.

Sampling bottles are labeled and prepared at the USGS preparatory lab in Denver in advance of ground-water sampling. This work is done in Denver instead of at the field site to prevent field contamination, facilitate access to supplies, and increase the efficiency of sampling.

Biosolids are not applied as a continuous layer on the Metro District farm fields. Instead, biosolids are sprinkled on the fields, which results in isolated clumps (that shown is about 6 inches across).

The USGS reports trace-element concentrations of the study-area ground water at parts per billion levels. Therefore, preparation of sampling bottles includes rinsing the bottles three times with deionized water at the USGS preparatory lab in Denver.

Surface-Water Sediments

Approach

Surface-water contamination is a concern for the stakeholders, but streams flow off the Metro District properties only during runoff when surface-water sampling is impractical. Therefore, possible surface-water contamination from metals will be evaluated by sampling streambed sediments soon after storms. Two small drainage basins were selected for similar characteristics but different land use—one drainage in a biosolids-application field and another drainage in a farmed field (not on the Metro District properties) that does not receive biosolids.

A downstream location in each of the two drainage basins will be sampled after the same storms, three to four times per year for inorganic constituents (including met-

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Surface-Water Sediments

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als, total nitrogen, and total phosphorous) and organic carbon, and one time per year for radioactive constituents. Data will be reviewed and statistically tested to determine if concentrations are significantly different between the two drainage basins.

Progress Last Quarter (October-December 2000)

The site was carefully monitored for runoff-producing rainfall. Despite rainfall October 20-23, 2000, runoff did not occur so no samples were collected.

Plans for Current Quarter (January-March 2001)

The site will be monitored for runoff-producing rainfall. Sampling may take place, depending on the weather. All data obtained from the program to date will be compiled, reviewed, and evaluated. The second annual report (2000 data) will be started.

Biosolids

Approach

Biosolids samples will be taken as a 24-hour composite from the Metro District plant and analyzed by USGS. Biosolids will be sampled and analyzed once each quarter during most of the program, and once each month for 6 months when the Lowry Landfill Superfund Site water transfer begins. Data will be reviewed and compared to Federal regulatory limits.

Progress Last Quarter (October-December 2000)

Monthly sampling of biosolids continued to check if processing of the Lowry Landfill Superfund site effluent by the Metro District caused any change to the composition of the biosolids. Each sample was a 24-hour composite from the conveyor belt at the Metro District facility. The material from each of the two collections was placed in two acid-washed, one-gallon plastic bottles and transported to the USGS in Lakewood. There, the samples were air-dried prior to grinding to less than 150 micrometers. Chemical analyses were initiated.

Plans for Current Quarter (January-March 2001)

The January sampling will complete the 6 months of monthly sampling. A quarterly sampling schedule will then resume after January. The chemical analyses of all six of the monthly samples will be competed. All data obtained from the program to date will be compiled, reviewed, and evaluated.

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The wheat collected from the USGS soil-sampling areas in late September 2000 was milled at the USGS laboratories in Denver before analysis.

Biosolids

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The second annual report (2000 data) will be started.

Soils

Approach

One site was selected for characterizing and monitoring the chemical composition of soil on the Metro District property in Arapahoe County, and one site was selected on the Metro District property in Elbert County. Each site consists of three 20-acre (933 feet by 933 feet) fields separated by 100-foot buffer zones. The center 20-acre field at each site will have biosolids applied after the initial soil sampling. The other two 20-acre fields at each site will not have biosolids applied and will be used as "control" fields to monitor the natural varibility of soil composition for the duration of the study. All three 20-acre fields at each site will be farmed in the normal fashion and have crops planted and harvested. Soils from each of the six fields will be sampled before biosolids are applied to the two center fields and then again after each harvest. Samples will be analyzed for arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, plutonium, and gross alpha and beta activity. Data will be examined after 5 years to determine if concentration has changed with time.

The milled wheat was weighed at the USGS laboratories in Denver before it was ashed and then analyzed.

Progress Last Quarter (October–December 2000)

Soil samples from the Elbert County site were collected November 29-December 1. These samples represent the first soil samples collected since the application of biosolids to the site.

Plans for Current Quarter (January-March 2001)

Weather permitting, the Arapahoe County site will be sampled. All data obtained from the program to date will be compiled, reviewed, and evaluated. The second annual report (2000 data) will be started.

Crops

Approach

Crops from each of the six 20-acre soil-monitoring fields will be chemically analyzed after harvest. Analyses will include arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.

Progress Last Quarter (October-December 2000)

The samples collected in September were dried, milled, and ashed at the USGS laboratories in Denver, then submitted for analysis. Chemical analyses of the wheat and millet samples from the Elbert and Arapahoe County soil sites were partially completed.

Plans for Current Quarter (January-March 2001)

Chemical analyses of the wheat and millet samples should be completed. All data obtained from the program to date will be compiled, reviewed, and evaluated. The second annual report (2000 data) will be started.

If you have questions about the Expanded Monitoring Program, please contact Tracy Yager (see page 12). Commonly asked questions will be included in each Quarterly Report.

USGS ground-water data, July–December 2000

[Standards from Colorado Department of Public Health and Environment, 1997, Basic standards for ground water, 5CCR 1002-41: July 14, 1997, 56 p. Data are preliminary and subject to revision. All data from filtered samples; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; E, value estimated by laboratory]

Well	Sample Date	Time	Nitrate plus nitrite as nitrogen, mg/L	Arsenic, µg/L	Cadmium, µg/L	Chromium, µg/L	Copper, µg/L	Lead, µg/L	Mercury, µg/L	Molybdenum, µg/L	Nickel, µg/L	Selenium, µg/L	Zinc, µg/L
DTX3	07/10/00	1030	<0.037	<2.0	<1.0	<0.8	5	<1	<0.2	<1	9	14.1	5
DTX3	10/11/00	1030	4.23	<2.0	<.1	1.7	3	<1	<.2	1	2	16.5	2
D17	07/06/00	1320	5.68	E1.4	<1.0	<.8	1	<1	<.2	6	1	8.8	3
D17	10/10/00	1245	.679	E1.2	<.1	<.8	1	<1	<.2	6	1	7.5	<1
DTX4	07/11/00	1010	4.66	<2.0	<2.0	<.8	7	<1	<.2	<2	10	E2.0	10
DTX4	10/11/00	1215	6.52	<2.0	E.1	2.6	6	<1	<.2	1	8	11.6	5
DTX5	07/11/00	1150	<.037	<2.0	<2.0	<.8	7	<2	<.2	<2	10	<2.4	9
DTX5	10/16/00	1015	<.037	<2.0	<.1	<.8	7	<1	<.2	1	9	3.3	5
DTX6	07/13/00	1300	.232	<2.0	<1.0	<3.2	9	<1	<.2	<1	<1	E1.8	7
DTX6	10/11/00	1400	.222	<2.0	E.1	3.0	9	<1	<.2	1	3	3.7	7
D13	07/07/00	1230	E.032	<2.0	<1.0	E.4	2	<1	<.2	1	4	<2.4	3
D13	10/16/00	1215	.049	<2.0	E<.1	<.8	3	<1	<.2	1	2	E1.7	2
D29	07/06/00	1105	E.030	<2.0	<1.0	.9	8	<1	<.2	<1	24	E1.5	9
D29	10/12/00	1110	<.037	<2.0	E<.1	<.8	7	<1	<.2	1	7	3.3	13
D6	07/11/00	1345	14.4	E1.0	<7.0	<.8	35	<7	E.2	<7	20	8.8	42
D6	10/12/00	1300	14.6	3.2	.1	<.8	33	<1	<.2	4	8	15.1	22
D30	07/10/00	1245	<.037	<2.0	<1.0	<.8	12	<1	<.2	3	14	<2.4	11
D30	10/12/00	1450	<.037	E1.5	E<.1	<.8	9	<1	<.2	2	4	2.6	6
D25	07/06/00	1500	3.03	2.7	<1.0	<.8	10	<1	<.2	9	33	2.5	7
D25	10/10/00	1455	4.91	2.7	<2.0	4.4	9	<2	<.2	14	14	5.9	6
DTX10	07/13/00	1020	<.037	<2.0	<1.0	<3.2	6	<1	<.2	1	3	<2.4	6
DTX10	10/18/00	1040	<.037	<2.0	<.1	<.8	5	<1	<.2	1	1	<2.4	4
DTX8A	07/10/00	1505	<.037	<2.0	<1.0	<.8	3	<1	<.2	<1	3	<2.4	4
DTX8A	10/16/00	1435	<.037	<2.0	<.1	<.8	2	<1	<.2	1	2	<2.4	2
DTX2	07/07/00	1050	<.037	E1.3	<1.0	--	8	<1	<.2	2	15	E1.9	9
DTX2	10/17/00	1005	<.037	E1.3	<2.0	<.8	11	<2	<.2	<2	26	2.9	9
DTX1	07/07/00	0940	1.29	E2.0	<1.0	<.8	9	<1	<.2	6	16	E2.1	7
DTX1	10/17/00	1200	1.22	E1.9	<2.0	<.8	12	<2	<.2	7	31	3.4	8
Human Health Standard			10	10	5	100	1,000	50	2	None	100	50	5,000
Agricultural Standard			100	100	10	100	200	100	10	None	200	20	2,000

USGS plutonium data for monitoring wells, October 2000

[Standards from Colorado Department of Public Health and Environment, 1997, Basic standards for ground water, 5CCR 1002-41: July 14, 1997, 56 p. Data are preliminary and subject to revision. All data from unfiltered samples; pCi/L, picocuries per liter; analytical uncertainty (defined on page 12) reported is the two-sigma total propagated analytical uncertainty]

Well	Sample Date	Sample time	Plutonium-238, pCi/L	Plutonium-238, analytical uncertainty, pCi/L	Plutonium-238, minimum detectable concentration, pCi/L	Plutonium-239+240, pCi/L	Plutonium-239+240, analytical uncertainty, pCi/L	Plutonium-239+240, minimum detectable concentration, pCi/L
DTX3	10/11/00	1030	0	0.008	0.009	0.002	0.007	0.018
D17	10/10/00	1245	-0.001	0.002	0.011	0.002	0.003	0.004
DTX4	10/11/00	1215	-0.002	0.003	0.024	0.009	0.012	0.012
DTX5	10/16/00	1015	-0.001	0.002	0.016	0.003	0.006	0.008
DTX6	10/11/00	1400	0	0.004	0.004	0.002	0.003	0.004
D13	10/16/00	1215	0.001	0.009	0.026	0.002	0.008	0.022
D29	10/12/00	1110	-0.010	0.010	0.051	-0.002	0.005	0.034
D6	10/12/00	1300	0	0.007	0.008	0.001	0.007	0.020
D30	10/12/00	1450	-0.002	0.004	0.031	-0.002	0.004	0.031
D25	10/10/00	1455	0	0.008	0.009	0.003	0.006	0.009
DTX10A	10/18/00	1040	0.006	0.012	0.022	-0.001	0.010	0.030
DTX8A	10/16/00	1435	0	0.004	0.005	-0.001	0.001	0.010
DTX2	10/17/00	1005	0	0.007	0.008	0.000	0.007	0.008
DTX1	10/17/00	1200	0	0.012	0.014	0.005	0.010	0.014
Human Health Standard			none found			0.15		
Agricultural Standard			none found			none found		

USGS data for streambed sediments, July 17, 2000

[mg/kg, milligram per kilogram; µg/g, microgram per gram; g/kg, gram per kilogram; <, less than]

Constituent	Units	Biosolids-applied basin	Control basin (no biosolids)
Total Nitrogen	mg/kg	824.	836.
Phosphorus	mg/kg	120.	110.
Aluminum	µg/g	8,500.	9,240.
Arsenic	µg/g	<1.	<1.
Cadmium	µg/g	.11	.12
Chromium	µg/g	8.0.	10.
Copper	µg/g	12.3	10.5
Lead	µg/g	13.1	13.8
Mercury	µg/g	.02	.02
Molybdenum	µg/g	.18	.20
Nickel	µg/g	10.3	12.5
Selenium	µg/g	<1.	<1.
Zinc	µg/g	41.	44.
Carbon, inorganic	g/kg	4.7	4.1
Carbon, organic	g/kg	7.4	7.2

USGS gross alpha, gross beta, and plutonium data for streambed sediments, July 17, 2000, pCi/g

[pCi/g, picocurie per gram]

Constituent	Biosolids-applied basin	Control basin (no biosolids)
Gross alpha	9.78 +/- 8.8	10.4 +/- 9.3
Gross beta	44.3 +/- 7.7	44.2 +/- 15.4
Plutonium 238	0 +/- 0.004	0.003 +/- 0.006
Plutonium 239+240	0.002 +/- 0.006	0.002 +/- 0.008

USGS trace-element data for soil samples collected August 25-26, 1999, mg/kg

[All data were collected before any biosolids applications; mg/kg, milligram per kilogram, dry-weight basis; <, less than]

	Arapahoe County Site			Elbert County Site		
	North (Control) Field	Middle (Biosolids Application) Field	South (Control) Field	North (Control) Field	Middle (Biosolids Application) Field	South (Control) Field
Arsenic	7.0	6.6	6.4	11.2	14.1	13.9
Cadmium	0.18	0.28	0.20	0.21	0.21	0.24
Copper	19	17	15	22	21	18
Lead	17	21	19	26	36	24
Mercury	<0.02	<0.02	<0.02	0.03	0.04	0.03
Molybdenum	0.6	0.6	0.6	1.2	1.4	1.2
Nickel	13	15	11	22	21	18
Selenium	0.4	0.4	0.3	0.9	1.0	0.8
Zinc	60	63	58	90	90	78

USGS gross alpha, gross beta, and plutonium data for soil samples collected August 25-26, 1999, pCi/g

[All data were collected before any biosolids applications; pCi/g, picocurie per gram]

	Arapahoe County Site			Elbert County Site		
	North (Control) Field	Middle (Biosolids Application) Field	South (Control) Field	North (Control) Field	Middle (Biosolids Application) Field	South (Control) Field
Gross alpha	16 +/- 12	15 +/- 16	13 +/- 9	13 +/- 11	17 +/- 12	14 +/- 14
Gross beta	28 +/- 8	27 +/- 8	22 +/- 7	31 +/- 9	28 +/- 7	24 +/- 7
Plutonium 238	0.00 +/- 0.01	0.00 +/- 0.01	0.01 +/- 0.02	0.01 +/- 0.02	0.01 +/- 0.03	0.01 +/- 0.02
Plutonium 239+240	0.02 +/- 0.02	0.00 +/- 0.01	0.00 +/- 0.01	0.00 +/- 0.01	0.00 +/- 0.01	0.00 +/- 0.01

Dried grain (left) and milled grain (right) from samples collected in July 2000.

Biosolids were applied recently to the North Farm. As usual, the biosolids were applied according to agronomic rates, which is less than one percent of the recommended application rate for soil amendments applied to residential yards in Colorado (J.G. Crock, USGS, October 26, 2000, oral commun.).

Definitions

Analytical uncertainty—The possible range of the true value or error term contributed by bias and variability of the laboratory measurement technique. All laboratory data have associated uncertainty. Each sample value should be thought of as a range in concentration defined by the reported value plus or minus the analytical uncertainty. The true concentration usually is somewhere in this range, but not a precisely known point. For most analyses, the analytical uncertainty is not calculated for each sample but is estimated from bias and variability data derived from analyses of quality-assurance samples likes blanks and replicates. For radionuclide data, the analytical uncertainty is calculated individually for each sample for each analyte based on analytical and statistical variables.

Biosolids—Solid organic matter recovered from a sewage-treatment process that meets regulatory criteria for beneficial use, such as for fertilizer. Metro District applies Grade I, Class B biosolids at Deer Trail. Regulations require that land-applied biosolids must meet or exceed Grade II, Class B. Grade I exceeds Grade II.

Less than (<)—A designation for analytical results to indicate that a constituent was not present or was present at very low levels that the laboratory could not reliably determine. Note that the actual amount of this constituent in that sample is unknown and could be any amount between zero and the "less than" value.

Picocurie (pCi)—A unit of measurement of radioactivity. One curie is defined as the amount of a radionuclide in which the decay rate is 37 billion (37,000,000,000) disintegrations per second. One picocurie is one trillionth (1 / 1,000,000,000,000) of a curie.

Radionuclide—A radioactive atom characterized by a given number of neutrons and protons in its nucleus. For example, plutonium concentrations include plutonium-238 or plutonium-239, which are specific isotopes.

Stakeholder–Any person or group (including the Metro District) interested or concerned about the Expanded Monitoring Program.

Contacts

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Elbert County: Mary Sue Liss, 303-621-3144 (elconurse@bewellnet.com)
Contact Mary Sue for all changes to the mailing list.

State Biosolids Coordinator: Lori Tucker, 303-692-3613

U.S. Environmental Protection Agency: Bob Brobst, 303-312-6129

Second annual stakeholder meeting was held September 21, 2000, at the High School in Agate.

Prepared by Tracy Yager, Dave Smith, and Jim Crock (USGS) in cooperation with Metro Wastewater Reclamation District, February 2001

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